MEMORANDUM

Tetra Tech, Inc.
400 Red Brook Blvd., Suite 200
Owings Mills, MD 21117-6102
phone 410-356-8993
fax 410-356-9005

DATE: July 13, 2011

TO: Dan Graham, PacRim Coal, LP

FROM: Jerry Diamond and Henry Latimer

SUBJECT: Revision of site-specific Mn criteria based on EPA comments

Tetra Tech prepared a report, *Development of Site-Specific Human Health Water Quality Standards for Manganese for the Chuit River Basin, Alaska* (December 8, 2011). Two site-specific water quality criteria for human health for manganese were presented in this report. Specifically, these criteria were for a fish-consumption based dietary criterion and a fish and water consumption dietary criterion. PacRim received comments from EPA on the development of these two criteria.

Comments were provided on the R*f*D, the RSC, fish consumption rates, and bioaccumulation factors (BAFs) used in calculating these criteria. For clarity, we discuss the two site-specific criteria in order and reproduced the equations used to calculate each criterion. Following discussion of these comments, both of these criteria were revised by incorporation of these comments.

Fish-Consumption Criterion

The fish-consumption based dietary criterion was calculated using Equations 1 and 2 and the variables defined below these equations here:

Equation 1:

$$TRC = \frac{BW\ x\ (RfD \times RSC)}{\sum_{i=2}^{4} FIi}$$

Equation 2:

$$WQC = \frac{TRC}{BCF}$$

Where:

TRC = Fish tissue residue criterion (mg Mn/kg fish) for freshwater and estuarine fish
R*f*D = Reference dose (based on noncancer human health effects) of 0.14 mg/kg body weight per day (ATSDR, 2008)
RSC = Relative source contribution (subtracted from the R*f*d to account for marine fish consumption). Value of 0.2 selected.
BW = Human body weight default value of 70 kg
FI = Fish intake at trophic level (TL) I (I =2, 3, 4). Site-specific value of 0.201 kg/fish/day selected.
BCF = Bioconcentration factor. Sites-specific value of 3.4 selected.
WQC = Water quality criterion

Based upon the comments received from EPA it appears that EPA agrees that these equations were appropriate (with the small shift to multiply the R*f*D by the RSC rather than subtract the RSC from the R*f*D) for use in calculating the criterion. Further, the RfD value of 0.14 mg/kg body weight per day and the BW default value of 70 kg were determined to be appropriate for calculating this criterion. The remaining variables are discussed below.

RSC

EPA recommends a RSC of 0.2 applied as a multiplier to the RfD rather than as a value (in this case 0) subtracted from the RfD as was done in the December 8, 2010 report. This change indicates that consumers of fish from the Chuit get 20% of their dietary manganese from consuming fish from the Chuit. The use of a RSC of 20% is in keeping with the 2004 Health Advisory (HA) from EPA (2004) and is a very conservative approach .

FI

The default intake of fish for the general adult population is 0.0175 kg fish/day. For the residents of Tyonek (the community closest to the Chuit), there are several intake rates that could potentially be used. According to Alaska Department of Fish and Game (Stanek and Holen, 2006) residents of Tyonek, Alaska harvested 30,448 usable pounds of salmon in 2005/2006. During this period, salmon accounted for 69% of the harvest and non-salmon fish accounting for 5% (2,233 pounds) of the harvest (with mammals, plants, and mushrooms making up the remaining harvest). Stanke and Holen (2006) go on to note that the majority of non-salmon fish in the harvest were freshwater species. The population of Tyonek at this time was 202 residents.

Using these data and assuming equal distribution of fish consumption over 365 days, we can conservatively calculate that residents eat 0.187 kg salmon/person/day and 0.014 kg non-salmon fish/person/day. This is a conservative treatment of these data as it assumes that all harvested fish is consumed by humans within the community, there is no waste, and no fish are transferred out of the community. The value for salmon is considerably higher than the value of 0.0175

kg/day assumed by EPA (e.g., EPA 2001), while the value for non-salmon fish is slightly lower, but quite similar to EPA's assumed value. EPA comments suggest that a consumption rate of 0.201 kg/fish/person/day is appropriate for use in calculating a site-specific criterion for the Chuit. This is a conservative value as it overestimates the dietary component made up by salmon. A site-specific consumption rate for salmon of 0.187 kg salmon/person/day could be used and is appropriate for the Chuitna. However, a value of 0.201 kg fish/day will be used in accordance with EPA's recommendation.

BCF

A site-specific bioconcentration factor (BCF) is required to convert the tissue residue criterion (TRC) into a WQC. Because the salmon consumed by residents of Tyonek is primarily caught in Cook Inlet and in the lower reaches of the Chuit it was initially determined that using a salmon BAF for calculating the site-specific criterion was inappropriate. The harvested salmon have spent very little time (if any) in the Chuit and their manganese burden is primarily derived from marine exposure. Thus, a literature value for brown trout (17.8) was used in the initial calculation.

EPA's comments suggested that a BCF for salmon be used in calculating the site-specific criterion. PacRim collected adult salmon fillets for tissue residue analysis in September 2009 from sites 180 and 110 (PacRim 2010). This study determined that the highest observed manganese concentration in a replicate fillet sample was 0.360 mg/kg (collected from site 110 at the confluence of the Chuitna and 2004 Creek). The mean fillet manganese value for site 110 was 0.335 mg/kg and the value of the single replicate collected from site 180 was 0.270 mg/kg. Using these values and the total manganese values observed at these sites at the time of salmon collection, the site-specific BCF values for salmon range from 1.3 at Site 180 to 5.6 at Site 110. As directed by EPA's recommendation, a site-specific salmon BCF value will be used in calculating this criterion. However, it is reiterated that these BCF values are representative of the exposure of salmon in the <u>marine</u> environment rather than exposure in the Chuitna.

The site-specific BCF is most appropriately calculated as the mean of the two values (1.3 and 5.6), which results in a site-specific BAF of 3.45. This value will be used in calculating the site-specific criteria discussed here.

Resulting Fish-Consumption Criterion

As discussed, several conservative assumptions have been incorporated into selecting the RSC, salmon consumption rates, and the BAF for use in determining this criterion. Further, there are several potential values that can be selected for use as the consumption rate. Using the most conservative assumptions available (consumption rate of 0.201 kg fish/person/day and BCF of 3.4), the resulting criterion is 2.9 mg/L. This criterion was derived using conservative, site-specific values for selected variables and assumed conservative values for the remaining variables.

Site-specific Criterion for Consumption of Fish and Water

Although the Chuitna does not support a public water supply use, a site-specific criterion was developed based on consumption of fish as well as drinking water. This criterion was derived using EPA methodology (EPA 2000) and Equation 3, below. EPA comments on the use of this

equation focused on the specific values of several variables, but overall indicated that the equation used was appropriate. The values selected for RSC, BW, and DI were determined to be appropriate. EPA provided comments on the FI and BCF values which were common to both criteria and discussed above. For this criterion, the remaining comment focused on the application of a modifying factor to the RfD to account for the potential for increased sensitivity to manganese associated with the drinking water pathway. The equation for calculating the manganese criterion for consumption of water and fish is as follows:

Equation 3:

$$AWQC = RfD\ x\ RSC\ x\ (\frac{BW}{DI + \sum_{i=2}^{4}(FI_{\text{i}}\ \text{x}\ \text{BAF}_{\text{i}})})$$

Where:

AWQC = Ambient water quality criterion (mg Mn/L)
R*f*d = Reference dose (based on noncancer human health effects) of 0.14 mg/kg body weight per day (ATSDR, 2008)
RSC = Relative source contribution (fraction multiplied by the R*f*d to account for contributions from other sources of Mn). Value estimated at 0.2, which is most conservative value used under drinking water program.
BW = Human body weight default value of 70 kg
DI = Drinking water intake (2 L/day default). Value of 6 L/day selected following incorporation of the modifying factor of 3 suggested by EPA.
FI = Fish intake at trophic level (TL) I (I =2, 3, 4); Site-specific value of 0.201 kg/fish/day selected.
BAF = Site-specific bioconcentration factor (BCF) for salmon is 3.4 used.

R*f*D and Modifying Factor

EPA commented that use of an RfD of 0.14 mg/kg body weight per day was appropriate for the organism only criterion, but that a value of 0.05 mg/kg should be used for the criterion that takes into account drinking water. We concur that EPA has made the recommendation to include a modifying factor of 3 when addressing the drinking water pathway. In the 2004 HA (EPA 2004), the modifying factor is applied to the water drinking water intake (DI) value to change the default assumption of 2 L/day to 6 L/day. Following the guidance of EPA in calculating the HA, the RfD of 0.14 mg/kg should remain the same, but the modifying factor of 3 should be applied as a multiplier to the DI value to change the value from 2 L/day to 6 L/day.

Revised Site-Specific Criterion for Consumption of Fish and Water

EPA recommended that the RfD be reduced from 0.14 mg/kg to 0.05 mg/kg based upon the modifying factor of 3. However, in calculating the HA (EPA 2004) EPA applied this modifying factor to the DI variable (shifting it from 2 L/day to 6 L/day). Based on this, it has been concluded that the application of the modifying factor to the DI variable is more appropriate. Additionally, as with the criterion for fish consumption only, the most conservative values available were used (e.g., fish consumption value of 0.201 kg/fish/day). The resulting criterion for the consumption of fish and water is 0.29 mg/L. This value is identical to the HA of 0.3 mg/L previously recommended for adoption as a site-specific standard for manganese in the Chuitna.